ENTOMOLOGICAL PHASES OF THE 1933-34 BADGER

INSECT CONTROL PROJECTS

MODOC NATIONAL FOREST, CALIFORNIA

BY

K. A. SALMAN

Associate Entomologist

Berkeley, California

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MEMORANDUM FOR T. D. WOODBURY, ASSISTANT REGIONAL FORESTER

Accompanying this memorandum is a report entitled "Entomological Phases of the 1933-1934 Badger Insect Control Projects", which is an analysis of control project results in an attempt to determine basic ecological features of forest insect infestations. This report we know to be of a preliminary nature, chiefly in that it deals with but one season, one type of infestation and one area. It is the first time during the past few years that accurate enough entomological data for analysis has been secured from a control project without the immediate super vision of a Bureau of Entomology employee charged with securing the data.

The chief results secured by the study are given under "Discussions and Conclusions" in the report, and the possible application of the information is given under "Application".

It is hardly necessary to point out that the results of this study indicate conclusions of extreme importance to the Forest Service in the management and logging of overmature east side type timber, and to the Bureau of Entomology in its research on insect caused forest losses, as well as in an understanding of when, how and why insect control measures should be recommended. The single fact that the composition of an infestation is indicative of the environmental conditions shows much concerning the future of the infestations in those stands, providing environmental conditions remain fairly stable.

This study was planned for by placing men experienced in entomological work in charge of and on the spotting crews and in divorcing the spotting crews from the treating organization only insofar as emphasis was placed on accurary of records and spotting, rather than on production per man day. The spotting crews were amenable at all times to reasonable changes in the treating work necessitated by the weather, transportation difficulties and other elements affecting that portion of the project. The only practical deviation from previous project organizations was that the head spotter was given charge of the spotting crews and was responsible for the trees marked without interference by the treating foremen and was also responsible for the accuracy of the information secured on the records.

Criticism of this separation of spotting from treating has been made with recommendations to return the spotting to the supervision of the camp foreman and to return the spotters from a monthly to a day pay basis. This criticism was raised on the basis of administrative difficulties.

In previous control projects spotters were under the camp foreman and very usually paid by the day unless permanent employees contributed time. The Bureau of Entomology has recommended, after surveys, that control be done and has made estimates for the work. Although seasonal changes in infestation may be great, in general the necessity for control has been substantiated and, everything considered, the estimates have been close. The entire work has then been turned over to the Forest Service employees. Spotters have been hired and put on a producing basis, with work measured in quantity rather than accuracy of tree dimensions and entomological data.

Under such conditions treating has been fairly uniformly well done but spotting, which is the key to an accurate and efficient control project, has often been poorly done. It has been impossible to judge what was cut and what type of infestation was combatted, either to judge the effects of control or learn the characteristics of an infestation. It has also been impossible to analyze the project in any way when records were plainly incorrect entomologically, tree classes infested were marked with a view of an even distribution in all classes, diameters and heights were not checked, and when the marking of an extra large tree on the record might mean that the joke was on the treating crew when it found one of scarcely merchantable size. All these things have made the accurate statistics of administrative reports inaccurate and the records of no use whatever, except as a check of the fact that the treating crew reached the tree.

The forest insect drain on forest resources, which in late years has been much greater than the drain from fire, or even the amount of timber logged is of too much importance to treat in that manner. In addition the fact that our knowledge of infestations, and particularly of when, how and where our present methods of control are justified is inadequate, yet might easily be made more adequate by studies such as that accompanying this memorandum, makes it imperative that we try to get as much value from a control project as it is possible to secure.

For that reason some change in our handling of the key operation, spotting, is necessary. Men with technical training, having the ability to weigh the intangible factors and conscious of the necessity of doing good work, must be secured. Floating labor never will meet those requirements. The job is not a matter of so many hours for the checking of records often requires nights and some Sundays as well. For that reason, unless the pay is abnormally high, the day labor pay basis is unsatisfactory. Except where projects are admittedly undertaken for reasons other than entomological, the Bureau takes the responsibility for their initiation or rejection. If, and we believe it is so, spotting is as important in control or control research as it seems to be, we believe it necessary that the Bureau designate men for the work that it is sure will have the requirements. If administrative difficulties are raised by that action, which I cannot conceive, it would be better to provide the Bureau with funds to assume complete charge of all spotting operations and relegate only the actual mechanical phases of control to the local forest force.

TABLE OF CONTENTS

	Page
INTRODUCTION	1
THE BADGER SPRINGS PROJECT 1933-1934	2
TOPOGRAPHY	2
STAND	2
PROBLEMS OF INFESTATION IN RELATION TO AREA.	3
METHODS OF STUDY	3
ANALYSIS OF THE RECORDS	3
Intensity of Infestation	3
Tree Selection	4
Infestation Types	5
DISCUSSIONS AND CONCLUSIONS	6
Intensity of Infestation	6
Tree Selection	7
Infestation Types	9
APPLICATION	10
TABLE II	11
TABLE III	12
FIGURES 1 - 6	13-16
MAP	

ENTOMOLOGICAL PHASES OF THE 1933-34 BADGER INSECT CONTROL PROJECTS MODOC NATIONAL FOREST, CALIFORNIA

INTRODUCTION:

The administrative reports of barkbeetle control projects show primarily the costs of treating a certain volume of infested timber on a specific area. As a rule, the more important insects responsible for the killing of this timber are mentioned, but beyond this the records from the ordinary type of control job throw but little light upon the composition of the infestations, or the natural factors influencing its tendencies at the time of control work.

Since the start of research on barkbeetle losses in ponderosa pine stands, qualitative observations have indicated extreme variation in the volume and character of the infestations on any given area of sufficient size for any year or series of years. The underlying causes of these variations appear to be factors of climate, stand or insect activity. Only by the analysis of fairly detailed records secured from the sapwood along the entire bole of infested trees, is it possible to acquire a complete understanding of the bark surface composition of an infestation according to primary insect species. Such an understanding is essential in any study of the distribution of infestation types within a control area, the relation of such types to site and stand factors, and the significance of any variations or changes in these infestation types as an indicator or increasing or decreasing barkbeetle populations.

This report presents a study of the variations of infestation types, as they were shown by an exceptionally well kept set of spotters records on the Badger Springs Project of the Modoc National Forest during the winter of 1933-34. The significance of the spotting records has been checked by analysis of the entire infested length of 51 trees. The study is limited to an analysis of the infestation types as they occurred for one overwintering generation on a specific area, with the purpose of determining where and how certain outstanding variations occurred.

To Head Spotter Frederic W. Bacon was given the responsibility of securing accurate entomological records from this project. It is a sincere pleasure to attribute much of the apparent success of the analysis to the careful and painstaking work done by Mr. Bacon and the spotters working with him. The lack of success of similar analyses attempted during the past two years, is attributed largely to the inaccuracies of the basic entomological data.

THE BADGER SPRINGS PROJECT 1933-1934:

The control reports for the NIRA and ECW projects were prepared by foremen Hodson and Buck. These show that 5,828 trees having a volume of a little over 5½ million board feet were treated on over 41,000 acres. A project map (fig. 5) showing the location of the infested trees was prepared for use with that report.

In view of the light infestation that was expected for the 1933 season, the intensity of the overwintering infestation shown on the project map gives one somewhat of a shock. It was known that the infestation of 1932 was aggressively on the increase. The population of the overwintering broods of that year were greatly reduced through the effect of killing low temperatures. The infestation for the 1933 season started with a barkbeetle population greatly reduced in numbers. Plot cruises conducted through the season indicated that the infestation was rapidly building up on the area. Up until the middle of October, however, there was little evidence to forecast the remarkable recovery of the beetles that is shown by the heavily spotted project map.

Distinct variations in amount of infestation are shown, the fringes of the timber belt suffering from a much heavier loss than did the stands well within the main body of timber. Study of the treating results not only shows differences in the amount of infestation but differences in species composition (basal examinations) as well.

The manner in which the infestation varied in the several sub-areas (fig. 6) of the project, as well as the reasons underlying this variance, are ecological problems. If accurate entomological records can be secured from control projects, it may be possible, by studying variation of infestations in relation to environmental and stand conditions, to solve problems that could not be attacked by laboratory methods.

TOPOGRAPHY:

The project area has no distinctive topographic features, although Plum Ridge (T.43N, R. 7E), Deer Hill (Sec. 34, T. 44N, R. 7E) and a small hill in Sec. 16, T. 44N, R. 8E, grace several maps. Deer Hill alone is distinctive enough to be indicated on the topographic maps of the Geological Survey by a 200 foot contour interval. Altitude ranges from about 4,500 feet to a little over 5,000 feet, the increase in altitude being fairly even and in general from west to east.

STAND:

The quality of the timber on the northern and western boundaries of the project, is poor site IV. To the east and south, this

changes to a fairly good site IV, and along the southern boundary of the project area are some site III areas. Measurement of increment borings on a plot in site III timber just south of the southern boundary of the project showed an average annual increment of but about 38 b.m. per acre. Growth figures for that plot, applied to one in Sec. 16, T. 44N, R 8E, which is within the project area, indicate a probable annual increment of but 25 b.m. per acre per year. This plot is in the fair quality site IV timber.

Although various estimates of green stand have shown an average volume of about 14,000 b.m. to the acre, it is doubtful if, except in some of the site III areas more than from 7,000 to 10,000 b.m. per acre remains. Three insect control projects directed against but partial seasonal losses during the period of 1928 to 1932, have taken out an average of over 1,000 b.m. per acre. It is probable that figure is less than one-third of the total loss for the four year period. The volume per acre is less towards the fringe of the timber belt so that equal losses in terms of board feet or trees per acre represent greater percent of the stand killed by the over-wintering 1933 broods.

PROBLEMS OF INFESTATION IN RELATION TO AREA:

Area infestation studies may cover three primary phases. These are (1) distribution of intensity of infestation in terms of number of trees or volume per unit timbered area and percent of stand per unit area; (2) distribution of types of trees attacked in terms of volume, tree classes, diameter classes and height classes; (3) distribution of infestation types in terms of insect species.

METHODS OF STUDY:

All tree records from both the NIRA and ECW insect control projects have been used as basic material. Each section, regardless of the total or timbered area was considered a unit and loss per acre in terms of trees and board feet was calculated on the basis of timbered acreage. It is realized that any given section may contain intensities or types of infestation that are radically dissimilar. It is believed, however, that this treatment of the data tends to obscure minor differences yet allows expression of the major features.

ANALYSIS OF THE RECORDS:

Intensity of Infestation.

Figure 6 shows the division of the project area into two types of zones. The zones labelled A, B and C and their subdivisions are based entirely on tree and volume losses per acre. Zones I to V are arbitrary zones based on distance from the fringe of timber. B.M. per acre losses in these zones are as follows:

TABLE I

Zone	B.M. per Acre	Zone	B.M. per acre
A	260	I	231
B	170	II	194
C	93	III	162
		IV	124
		V	97

Several points should be mentioned as regards the location of the zones based on infestation intensity. Zone A is closest the fringe of timber. Maximum loss in any section is 404 b.m. per acre and minimum is 195 b.m. A finger of heavy infestation comprising subzone A1 extends well into the main timber body, in fact, to the site III stands. No particular reason for this extension can be noted.

Zone B has a maximum loss of 234 b.m. per acre and a minimum of 102. This zone is typically an intermediate or buffer zone. The greater portion of it lies some distance from the fringe of timber except west of Horse Camp. This zone borders Zone A on the interior in practically all cases. Zone C is the lower loss areas having a maximum loss of 153 b.m. per acre and a minimum of 33 b.m. It is entirely within the timber body but encompasses the extensive non-timbered flats shown on the maps (Figs. 5 & 6).

The arbitrary zonation of the area gives figures comparable to those secured by the segregation of different infestation intensities. It may be an entirely fortuitous circumstance in this area this year, that the relation between the amount of loss and the distance from the fringe is regular.

Tree Selection.

Table II deals with tree selection on the basis of Keen's tree classes, diameters and heights. Further information is given in Table III, which deals with selection according to age, thrift and Dunning's tree classification. The proportion of the green stand of the west half of section 16, T. 44N, R 8E that falls in the 16 tree classes is given in each table for comparison. Percentage figures have been carried to the second decimal place and total to within 0.08%. Figure I shows the types of trees concerned in nearly 92% of the losses. (Tables II and III on pages 11 & 12.)

It is worthy of note that some losses were found in all tree classes except 1C and 1D. The greater portion of the losses were in age classes 3 and 4.

In order to determine if there was any relationship between the amount of infestation and the size of trees infested, the number of infested trees per acre were graphed over b.m. per acre for each section in the project area, with the relationship of the average tree cut on the project as a comparison. This information is given in Figure 2.

Infestation Types.

The three insect species primarily involved in the 1933 overwintering infestation are the western pine beetle (Dendroctonus brevicomis), the mountain pine beetle (Dendroctonus monticolae) and flathead borers (Melanophila gentilis and M. californica). The only other species noted in basal examination records is the large engraver beetle (Ips. emarginatus) which was found in but a few trees with the above named primary species. (1)

The combinations in which each of the primary insect species occur with other species are as follows:

D. brevicomis	D. monticolae	Melanophila sp.
DB- DM	DM- DB	FH- DB
DB- FH	DM- FH	FH- DM
DB- DM- FH	DM- DB- FH	FH- DB- DM
DB- IPS- et al	DM- IPS- et al	FH- IPS- et al

In terms of B. M. loss, the relationships of the three primary insect species, either attacking alone or in combination with other species is shown in the following table and in figure 3.

TABLE IV

Basis - % of total infested trees and volume
BASAL EXAMINATIONS

Insect Species	Pure Infestation		Mixed Infestation		Total Infestation	
	Trees	Volume	Trees	Volume	Trees	Volume
DB	31.87	37.35	28.36	31.59	60.23	68.94
DM	10.59	6.36	24.16	22.83	34.75	29.19
FH	19.17	16.14	26.31	30.47	47.48	46.61

Analysis has been made, by zones, of the amount of volume loss per acre, percent of total infestation caused in pure attacks by DB and FH and the total percent of infestation resulting from pure attacks of the two species. This information is given in the following table:

TABLE V

Zone Designation	ZONE AVERAGES			
	B.M. per acre:	% pure DB:	% pure F.H.:	% pure DB +FH
A.....	260	30.6	23.7	54.3
Subzone A.....	262	21.6	38.2	59.8
" A1.....	257	42.8	4.3	47.1
" A2.....	265	27.0	28.8	55.8

(1) In this paper the following symbols have been used in tables and text to refer to the different species:

DB - D. brevicomis
DM - D. monticolae
FH- Melanophila gentilis and M. californica
Ips- Ips emarginatus

TABLE V (cont'd)

ZONE DESIGNATION	ZONE AVERAGES			
	B.M. per acre	% pure DB	% pure FH	% pure DB+FH
B.....	170	39.2	13.2	52.4
Subzone B.....	157	27.8	22.5	50.3
" B1.....	157	31.1	21.8	52.9
" B2.....	184	48.9	3.8	52.7
C.....	93	42.5	11.0	53.5
Subzone C.....	98	46.0	11.0	57.0
" C1.....	70	27.2	10.9	38.1
I.....	231	23.2	34.6	57.8
II.....	194	34.5	16.3	50.8
III.....	162	44.6	9.4	54.0
IV.....	124	42.4	10.8	53.2
V.....	97	45.2	6.1	51.3

DISCUSSIONS AND CONCLUSIONS:

Intensity of Infestation.

Figure 2 shows that there is little difference throughout the project area in the size of trees infested regardless of the amount of loss per acre. What differences occur can be attributed to natural variations in stand conditions.

Figure 5 maps the location of the infestation and Figure 6 shows the selected and arbitrary zones. Figure 4 shows the losses given in Table II.

As far as amount of loss is concerned and regardless of the zonation used, the stands nearest the fringe of timber suffer the greater loss, while those farther from the fringe suffer less loss. There may be, in general, two basic reasons for this. The first is that the health of the individual trees in the stands is the basic factor concerned in insect attack. The second is that the location of optimum conditions for brood development is the basic factor. Combination of the two factors is possible; in fact, probable.

The fringe of timber represents environmental conditions that are at the critical point as far as tolerance by the trees is converned. Distance from the fringe in large timbered areas ordinarily indicates a lessening of environmental pressure on the tree species. However, islands of critical conditions may occur within the main timber body. Considering losses alone, and without consideration of composition of infestation, it would appear, due to the decrease in

losses in relation to distance from the fringe and due to the fact that all heavily infested ares are adjacent to or reach into the main timber body from the fringe, that losses vary directly with the extent of the pressure of physical environmental factors. It is apparent, that the sometimes extensive openings within the main body of timber cannot be considered fringe for better quality timber occurs about their margins and insect losses are lighter.

When the composition of infestation is considered the theory that environmental pressure is a basic cause of losses does not seem to fit the situation. When b.m. per acre and percent of total infestation caused by DB and FH attacks (figure 4) are studied, it would appear that the heavier losses towards the fringe are due to the fact that the fringe is the optimum for FH activity and by no means the area of minimum DB activity. The regular decrease in total losses appears to be the result of rapid regression from the zone of optimum FH conditions and gradual assumption of more favorable conditions for DB brood until about two miles from the fringe optimum conditions for that species are found. Continuing inward from the fringe there is a gradual regression from the optimum for DB and an approach to the minimum, or perhaps maximum, limiting environmental conditions for FH. The fact that there is no discernible difference in tree size or thrift and age classes infested towards the fringe of the timber body would indicate losses are not so much the result of tree debility as of insect activity. The distribution of losses in this area this season, as well as the amount of activity by Flathead borers must cause us to revise our estimate of them as somewhat secondary insects and consider them an active and devastating species occupying an ecological niche having extreme conditions. The secondary role of flathead borers has largely been assumed after work on primarily western pine beetle infestations. The fact that the environmental requirements of the two species appear to be different would account for that assumption.

Tree Selection.

Figure 2 indicates the average volume of infested trees does not vary greatly regardless of the amount of loss. There is no indication that the average dimensions of infested trees have become less with greater per acre loss or that any infestation in the area this year can be considered as epidemic so far as DB is concerned. Analysis of plot loss figures during non epidemic and epidemic cycles has shown size of tree decreases greatly during DB epidemics and this fact is the basis of our statement. There is not sufficient information on the characteristics of FH epidemics, however, to judge if the 1933 overwintering conditions are indicative of epidemic conditions of infestation by that species.

Although all tree classes except class 1C and 1D are represented by infested individuals as shown in figure 1, nearly 80% of the losses are in the overmature classes, 4B, 4C, 4D and the only moderately thrifty mature class 3C, Examination also shows that 96.25% of the total number of trees infested are in Dunning's classes 4, 5 and 6.

If we can apply the figures on composition of the green stand secured in 1931 on 320 acres in Section 16, T 44 N, R 8 E, which is within the project area, to the figures on losses (Tables II & III), it is seen that classes 1A to 2D are infested much less than their proportional abundance in the green stand. In the four classes under age class 3 the loss in 3C alone approaches the relation of that class to the green stand. In class 4 losses in class 4B are about 77% of its proportion of the green stand, 4C is about 7½ times its proportion and 4D is 3.6 times its proportion of the entire green stand.

Considering age alone infestation in Class 4 is the only one in which infestation exceeds the proportionate part of that class in the stand. Considering thrift alone, infestation in both C and D classes exceeds their proportionate part in the stand. Under Dunning's classification classes 1, 2, 3 and 4 apparently had less than an even chance of being infested last fall whereas classes 5, 6 and 7 had a greater than even chance of infestation.

Results of study of tree selection by the different types of infestation may be stated as follows: On the average -

1. In an infestation by DB, trees of greater than average diameter and height are infested with a greater than average infestation in the overmature tree classes. There is a fairly normal spread in the thrift classes.

2. In an infestation by DM, trees of less than average diameter and height are infested with a greater than average infestation in the immature and growing age classes and the unthrifty or suppressed tree classes.

3. In infestation by FH., trees of approximately average diameter and height are selected with a fairly average selection of the thrift classes. Mature but not overmature trees appear to be favored for infestation.

4. In infestation by DB-DM, the figures for diameter, height, age and thrift are nearly average with some tendency to greater selection of the suppressed thrift classes.

5. In infestation by DB-FH average diameters and heights of infested trees are slightly above normal. A greater than normal infestation occurs in the overmature types of trees and trees of intermediate thrift are favored.

6. In infestation by DM-FH, tendencies are towards infestation of smaller trees with favor towards infestation of the younger and thrifty or suppressed trees.

7. In infestation by DB-DM-FH approximately average sized trees are infested. Overmature trees in the intermediate thrift classes appear to be favored.

8. In infestation by Ips-emarginatus and other insects larger than

average trees are selected although overmature trees in the less thrifty classes do not appear to be selected as often as the mature and more thrifty individuals.

Infestation Types.

The classifications given in Table II are the results of basal examinations alone. Analyses of infested lengths of 51 entire trees showed that, although trees marked pure FH may have partial infestations by other species higher on the bole than could be reached in a basal examination, for the most part such trees contained a nearly pure brood of the single species. The same conditions, but to a less complete extent, were noted in trees marked pure DB. In most of the trees attacked by that species the greater portion of the bole was infested by DB brood only, while pure FH or FH and DB together filled in the upper and smaller portions of the trees. It was found that mixed infestations in the bases of the trees were not as true an index of mid and upper bole infestations and so were not used as indices of infestation donditions.

Table V shows that, in general and regardless of whether the selective or arbitrary zonation is used, there appears to be a direct relationship between the total B.M. per acre loss and B.M. per acre loss due to pure FH attacks or percent of infestation caused by pure attacks of that species. Also there appears to be an inverse relationship between b.m. per acre loss and percent of infestation caused by pure DB attacks. There does not appear to be the same relationship with the B.M. per acre loss caused by pure DB attacks in the arbitrary zonation although when the area is selected on the basis of amount of infestation the relationship appears to be better.

It would appear that the variation in the percent of total infestation caused by pure attacks of DB and FH together is small compared with the range of the average total loss b.m. per acre loss or the variation in amount of loss or percent of total loss caused by either species. It may be that the loss caused by pure attacks of DB and FH shows a stability this year but will vary in other years, or the stability may be indicative of conditions due to basic feators. In such an event knowledge of that amount of loss would be an excellent index measurement of the affects of those factors. The relationship between amount of loss per acre and amount of or percent of total loss caused by Flatheads may be useful as an index as well. It appears to be an index this season but knowledge of conditions in other seasons is necessary before definite conclusions can be drawn.

The subzones, labelled as such in Table V, show that, given approximately equal volume losses per acre, the proportion of pure infestation by either DB or FH may be quite unlike in the eifferent areas. Areas A and A2 can be grouped as amount of loss and percent of pure loss caused by the two primary species is similar. Area A1, although having a b.m. per acre loss comparable to that in the other two subzones, has

a greater proportion of the total loss caused by pure attacjs of DB and considerably less caused by pureFH. For the same reasons subzones B and B1 should be grouped as similar while B2 corresponds to A1 as far as attacks by DB and FH are concerned. Although zone C has been divided, there is little difference in the composition of the infestation. A few sections show an extremely low FH attacj and a high DB attack but the differences between those areas and the remainder of the zone are not distinct.

APPLICATION:

Under the conditions of infestation now present in the Badger area, it is evident that the following points brought out by this analysis are pertinent in their application to management and protection of the stands.

1. The amount of loss is evidence of insect activity but heavy losses are not necessarily the results of epidemic western pine beetle infestations.

2. The importance of Flatheads and mountain pine beetles in this infestation, although possibly due in part to reduction in western pine beetle population by environmental factors, also appears to be the result of specifically increased activity of those species. This makes necessary consideration of those species in control projects as well as study of effects of control on them.

3. The variation in activity by the several species in portions of the area, coupled with an understanding of the habits, importance and possibilities of control of the so-called secondary species, which knowledge at present is only partial, appears to indicate a basis for determining the composition of an infestation by means of location and site quality.

4. The selection of overmature trees and trees in Dunning's classes 4, 5 and 7 to the extent of 96% of the total amount of volume killed furnishes information of value in salvage cuttings or management of stands. The apparent selection of certain types of trees by different species or species grouping is also of value and indicates those species which, because they apparently prefer immature and mature trees, or even thrifty trees, may be the important factors in cutover losses.

1933-34 INSECT CONTROL PROJECTS - MODOC NATIONAL FOREST
AVERAGE DIAMETERS, HEIGHTS AND % TOTAL INFESTED TREES

TABLE II

		1				2				3				4			
		A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Ave. all trees, Ins.	DBH:	12.0	12.0	-	-	16.4	16.4	14.9	13.1	24.0	22.7	20.5	17.5	32.7	32.7	30.8	22.9
	Logs, HT:	1.0	1.0	-	-	1.5	1.7	1.5	1.1	3.1	3.0	2.7	1.9	4.5	4.7	4.5	3.8
	% Total inf.:	0.02	0.02	-	-	0.50	0.24	1.68	0.19	0.35	8.77	13.50	1.65	0.19	7.94	65.25	7.05
RS5 Green Stand 1931	%:	0.03	0.03	0.03	0.03	9.34	10.44	2.74	0.05	7.74	26.07	16.99	1.64	4.14	10.35	5.53	1.95
	total no. trees:																
Ave. by Infestation Composition in Deviations from Average of all trees	DB DBH:	-	0.0	-	-	+0.1	+1.2	+1.1	-1.1	+1.3	+0.4	+1.1	+2.2	-	+1.2	+0.2	+1.7
	HT:	-	+0.0	-	-	+0.1	+0.5	+0.3	-0.1	+0.9	+0.1	+0.3	+0.6	-	+0.2	0.0	+0.3
	% total:	-	+0.03	-	-	-0.07	-0.57	-0.93	-0.14	-0.03	-0.77	-3.12	-0.93	-	+2.95	+5.11	+0.41
	DM DBH:	-	-	-	-	-2.0	-2.5	-1.2	-0.6	-4.0	-3.4	-1.6	-2.2	-	+2.8	-3.5	-5.1
	HT:	-	-	-	-	-0.2	-0.4	-0.3	-0.1	-0.1	-0.7	-0.2	-0.5	-	+0.2	-0.2	-0.4
	% total:	-	-	-	-	+0.98	+1.14	+4.25	+0.80	-0.19	-0.30	+11.39	+4.14	-	-4.32	-21.52	+3.82
	FH DBH:	0.0	-	-	-	+0.4	+1.1	+2.1	-0.4	-1.3	+2.0	+0.3	+2.1	-0.7	-2.6	-1.4	-0.8
	HT:	0.0	-	-	-	+0.5	+0.1	+0.2	+0.8	-0.6	-0.1	-0.2	+0.1	-2.5	-0.5	-0.5	-0.5
	% total:	+0.07	-	-	-	-0.05	+0.26	-0.58	+0.09	+0.43	+1.09	+3.43	-0.34	-0.01	+0.06	-2.09	-2.36
	DB DM DBH:	-	-	-	-	-0.4	+2.6	-0.4	-	-4.0	-2.0	-0.6	-0.7	+5.3	-0.8	-1.9	-1.2
	HT:	-	-	-	-	-0.5	+0.5	-0.2	-	-0.1	+0.1	-0.1	-0.5	+0.5	+0.1	0.0	+0.1
	% total:	-	-	-	-	-0.34	-0.51	-0.35	-	-0.19	-0.41	+0.37	+1.24	+0.06	-0.67	-1.10	+2.08
	DB FH DBH:	-	-	-	-	-2.4	-4.4	+3.4	-	+4.0	-1.8	+0.8	+4.2	-1.2	+0.7	+0.1	+4.6
	HT:	-	-	-	-	-0.5	-0.7	+1.5	-	-0.1	-0.2	+0.2	+0.8	+0.5	0.0	+0.1	+0.4
	% total:	-	-	-	-	-0.38	-0.72	-0.96	-	-0.23	-0.63	-6.66	-1.37	+0.38	+0.82	+12.47	-3.45
	DM FH DBH:	-	-	-	-	-1.7	+0.5	-0.4	-	-1.0	-0.2	-1.5	-1.5	-	-1.8	+9.5	-1.6
	HT:	-	-	-	-	-0.2	+0.1	-0.2	-	-0.1	+0.1	-0.3	-0.1	-	-0.3	+1.1	-0.4
	% total:	-	-	-	-	+0.10	+2.20	+2.18	-	+0.05	+2.51	+3.17	+0.19	-	-0.42	-12.96	+3.31
	DB DM FH DBH:	-	-	-	-	-2.4	+3.6	-2.9	-4.9	-	+0.6	+2.9	+14.5	-	+1.0	-0.7	+0.9
	HT:	-	-	-	-	-0.5	+0.5	-0.5	-0.1	-	+0.2	+0.6	+2.1	-	0.0	-0.1	+0.5
	% total:	-	-	-	-	+0.53	-0.40	-1.24	+0.85	-	-0.10	-5.06	-0.75	-	+1.40	+8.19	-2.16
Miscl.	DBH:	-	-	-	-	-	-	-	-	-	+11.3	+14.5	-	-	+3.3	+0.5	+5.1
	HT:	-	-	-	-	-	-	-	-	-	+1.0	+1.3	-	-	+0.3	+0.4	+1.2
	% total:	-	-	-	-	-	-	-	-	-	+5.48	+5.25	-	-	+4.56	-7.11	-0.80

SELECTION OF TREES ON BASIS OF AGE THRIFT AND DUNNING'S TREE CLASSIFICATION EXPRESSED IN % TOTAL INFESTED TREES IN GROUPS

TABLE III

	AGE				THRIFT				DUNNING'S CLASSIFICATION						
	1	2	3	4	A	B	C	D	1	2	3	4	5	6	7
Ave. all trees	0.04	3.21	18.25	78.54	0.97	11.57	78.54	8.87	0.58	2.54	0.45	16.27	71.30	0.19	8.68
B35 Green Stand 1931	0.16	22.56	52.45	24.81	21.27	46.93	28.13	3.65	9.37	13.30	7.74	45.06	22.86	0.05	3.59
DB	+.01	-1.71	-4.65	+6.48	-.22	-.16	+1.06	-.66	-.09	-1.47	-.15	-3.89	+6.36	-.14	-.52
DM	-	+7.17	+15.02	-22.21	+.67	-3.80	-5.90	+8.76	+.96	+5.37	-.29	+11.09	-25.94	+.80	+7.96
FH	+.05	-.25	+4.66	-4.49	+.49	+1.39	+.76	-2.61	+.02	-.34	+.47	+4.52	-2.03	+.09	-2.70
DB DM	-	-1.37	+1.01	+.28	-.49	-1.61	-1.06	+3.13	-.36	-.86	-.13	-.04	-1.77	-	+3.32
DB FH	-	-2.25	-8.89	+11.15	-.25	-.65	+8.36	-4.91	-.40	-1.70	+.15	-7.39	+14.29	-	-4.72
DM FH	-	+4.29	+5.92	-10.26	+.05	+4.27	-7.61	+3.51	+.08	+4.36	-.05	+8.68	-13.38	-	+5.50
DB DM FH	-	-1.01	-6.26	+7.84	-.09	+.93	+1.89	-2.66	+.36	-1.66	-	-5.16	+9.59	+.25	-2.91
Miscl.	-	-	+6.75	-3.54	-	+7.13	-3.54	-3.62	-	-	-	+8.73	-2.55	-	-2.45

Fig. 1.

1933-1934 INSECT CONTROL PROJECTS

MODOC NATIONAL FOREST, CALIFORNIA

IMPORTANT TYPES OF INFESTED TREES

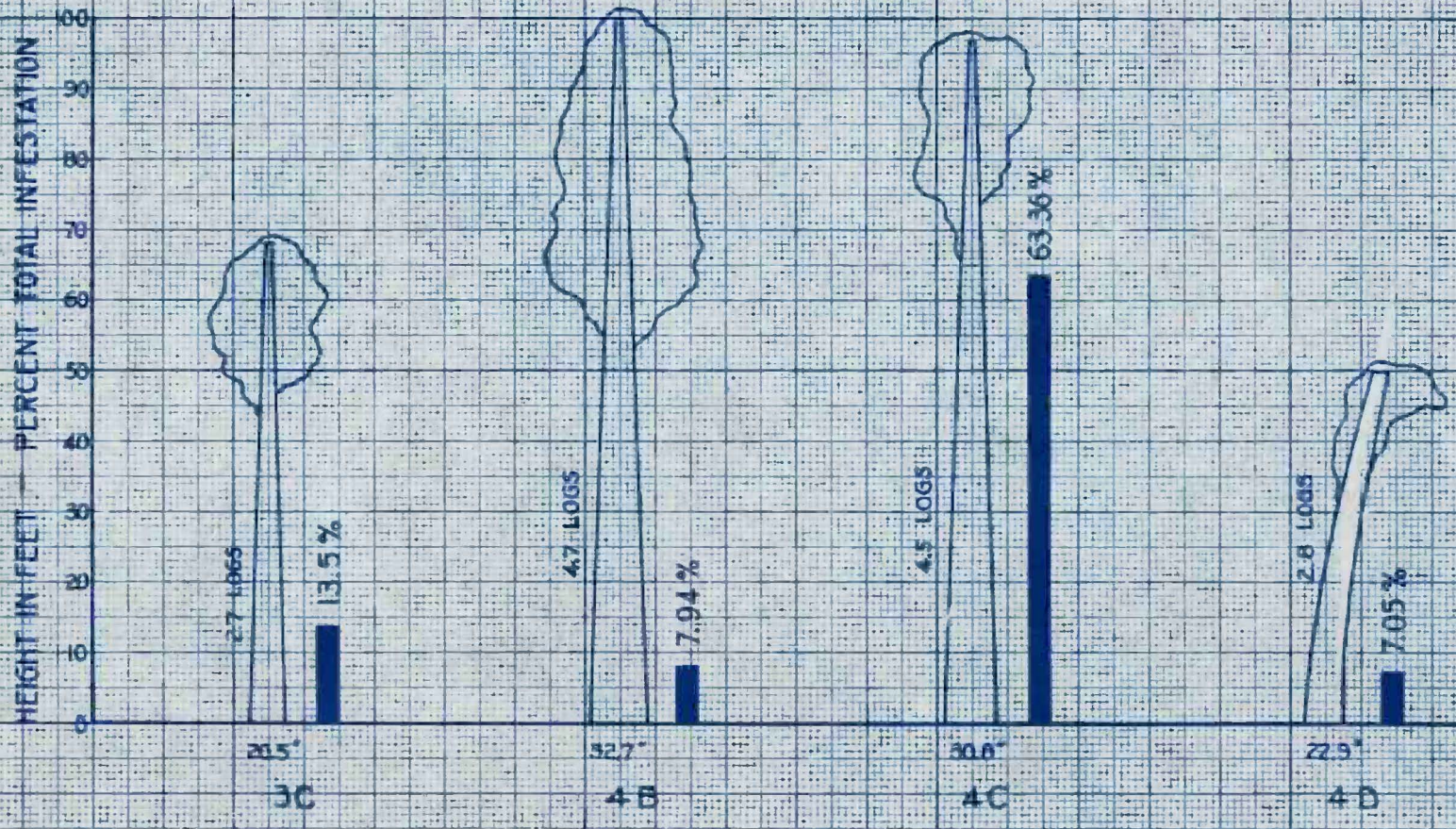


Fig. 2

1933-1934 INSECT CONTROL PROJECTS

MODOC NATIONAL FOREST, CALIFORNIA

RELATIONSHIP OF INFESTED TREES PER ACRE TO BOARD-FOOT LOSSES PER ACRE

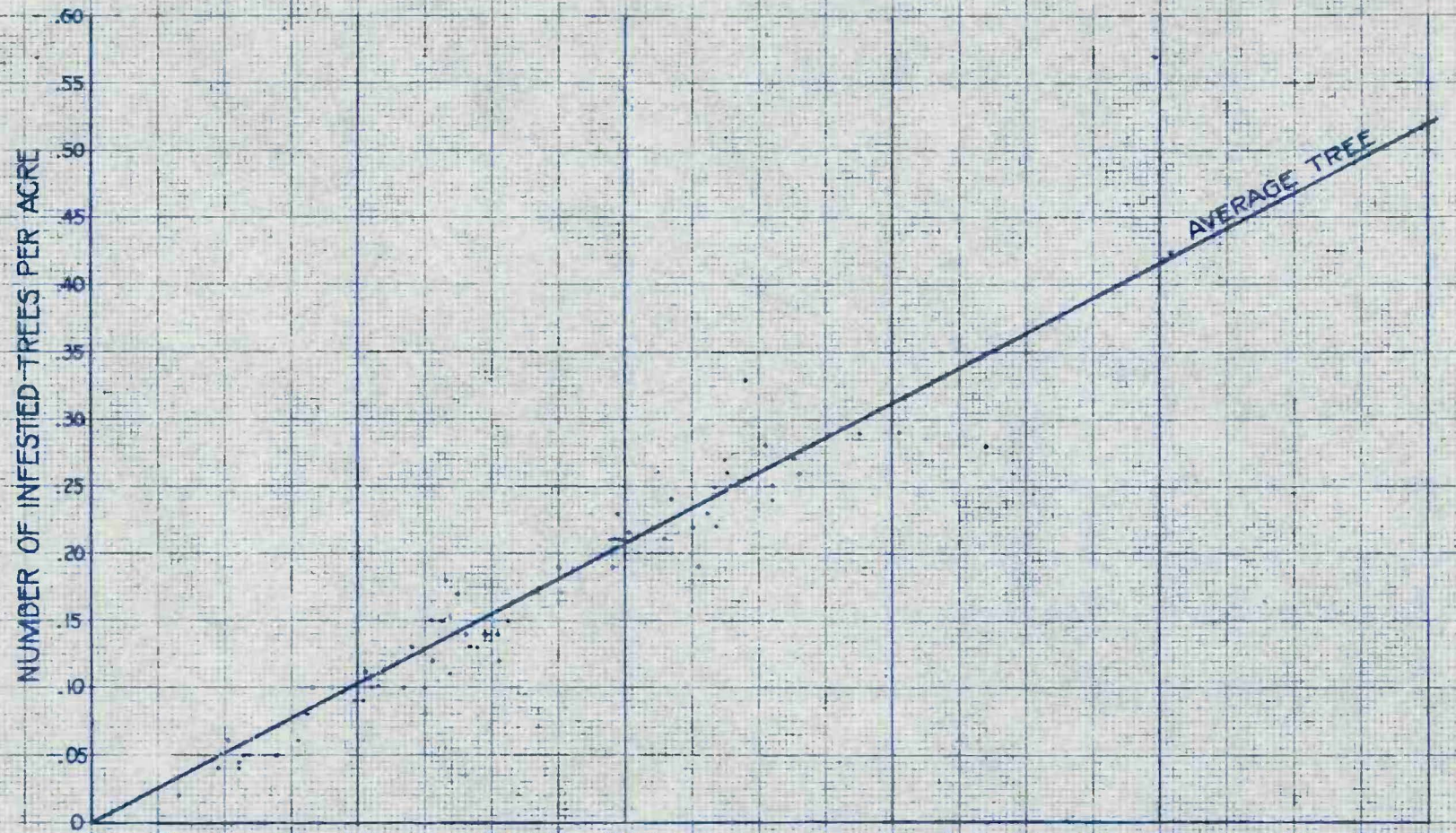
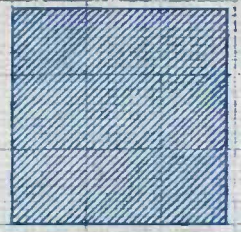


Fig. 3

1933-1934 INSECT CONTROL PROJECTS

MODOC NATIONAL FOREST, CALIFORNIA

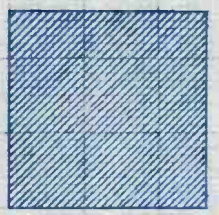
COMPOSITION OF INFESTATION - BASAL EXAMINATION



2,107,380 B.M.

37.4% OF TOTAL

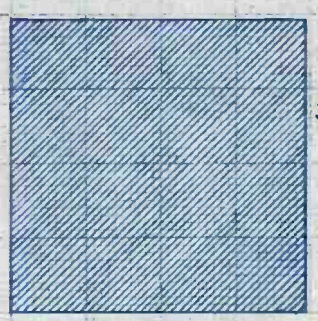
D. BREVICOMIS LEC.



1,782,010 B.M.

31.6% OF TOTAL

D.B. - MIXED BROOD



3,889,390 B.M.

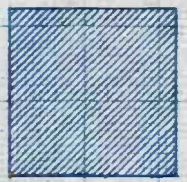
68.9% OF TOTAL

TOTAL D.B.

359,070 B.M.

6.4% OF TOTAL

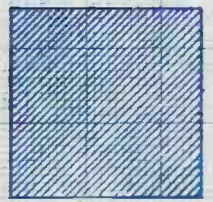
D. MONTICOLAE HOPK.



1,288,600 B.M.

22.8% OF TOTAL

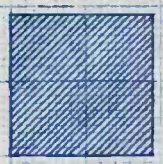
D.M. - MIXED BROOD



1,647,670 B.M

29.2% OF TOTAL

TOTAL D.M.



910,580 B.M.

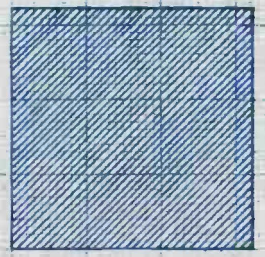
16.1% OF TOTAL

MELANOPHILA SPP.

1,719,530 B.M.

30.5% OF TOTAL

MELANOPHILA - MIXED BROOD



2,630,110 B.M

46.6% OF TOTAL

TOTAL *MELANOPHILA*

PURE INFESTATION

MIXED INFESTATION

TOTAL INFESTATION

354

Fig 4

1933-1934 INSECT CONTROL PROJECTS

MODOC NATIONAL FOREST, CALIFORNIA

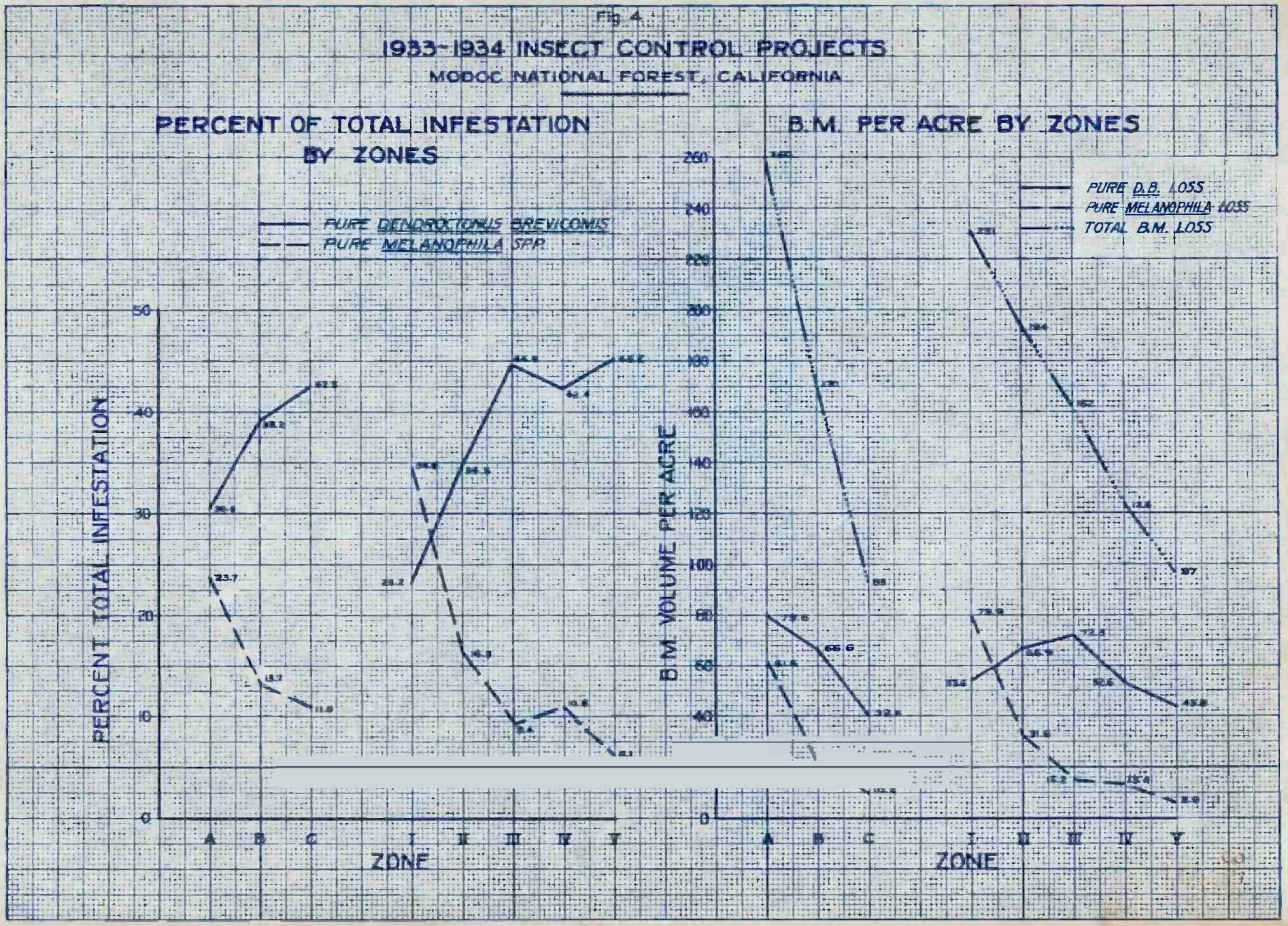


FIG. 5 AND 6

1933-1934 INSECT CONTROL PROJECTS

MODOC NATIONAL FOREST, CALIFORNIA

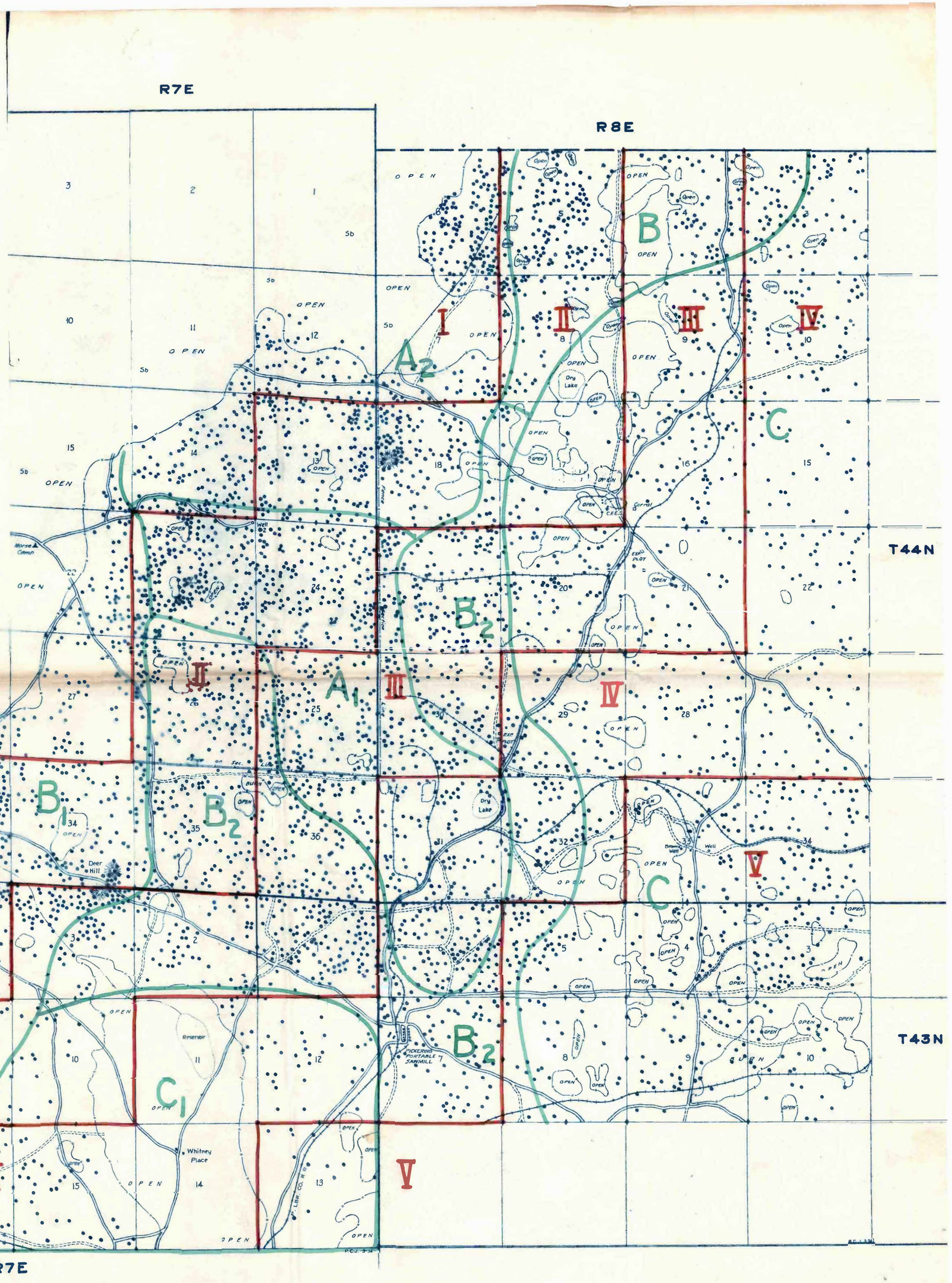


FIG. 5 AND 6

1933-1934 INSECT CONTROL PROJECTS

MODOC NATIONAL FOREST, CALIFORNIA